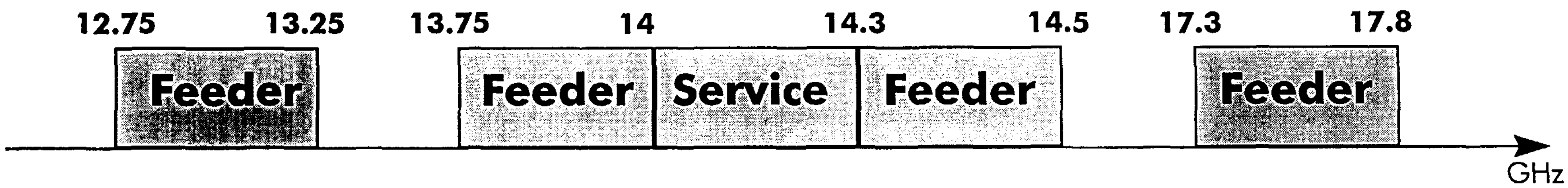
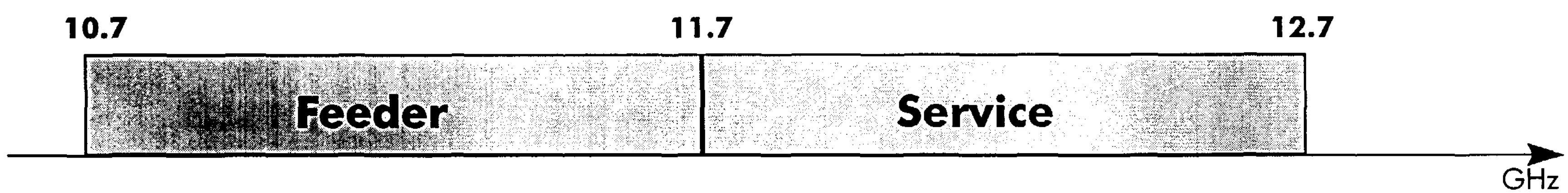
Frequency Re-Use with the Fixed Service

Proposed frequency band

Uplink



Downlink



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SkyBridge

FREQUENCY RE-USE

With FS systems on the terrestrial path

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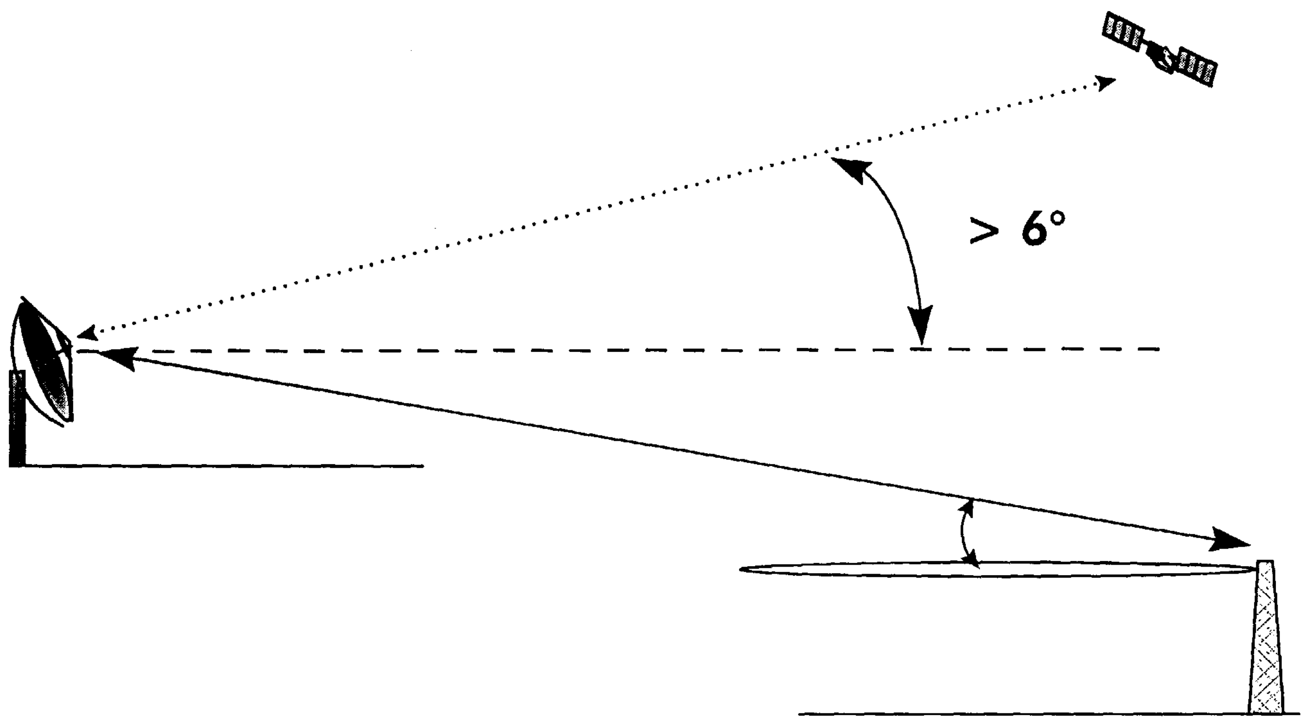
Frequency re-use on the terrestrial path

Frequency re-use geometry



SkyBridge

Frequency re-use on the terrestrial path

In bands used by FS systems in the US :

- **Only Gateways will be operated :**
  - ⇨ few in number (one per 350 km radius Cell) ; 30-40 throughout the US
  - ⇨ large antennas (2.5 m or 4.5 m)
  - ⇨ efficient antenna side-lobes

- **Coordination will be effected on a case-by-case basis**
  - ⇨ Gateways will be carefully sited in order to take into account the surrounding FS infrastructure

Frequency re-use on the terrestrial path

Proposed procedure for coordination of SkyBridge Gateways in the US :

Classical coordination procedures will apply, i.e. :

⇒ Determination of coordination contour around the Gateway site
- coordinates of the Gateway site
- horizon profile around the Gateway site,

⇒ Identification of the FS facilities inside the coordination area

⇒ Determination of the I/N ratio at the potentially interfered receiver (Gateway or FS) - calculation of separation distance
- terrain profile on the Gateway - FS path
- pointing azimuth of FS antenna
- statistics of Gateway antenna gain towards the horizon

Frequency re-use on the terrestrial path

Purpose of the calculation of separation distances

- I/N can be used in studies to determine separation distances
- Give an order of magnitude of the required separation between the Gateway and the FS system
- Worst-case analysis in terms of :
  - ⇒ Gateway antenna gain in the direction of the FS system
  - ⇒ propagation model (no terrain blockage)

Frequency re-use on the terrestrial path

Assumptions for evaluation of separation distances

- **Propagation model :**
  - ⇨ short distances : free space loss
  - ⇨ large distances : tropospheric scatter
  - ⇨ between : spherical diffraction
  - ⇨ terrain blockage : no
- **Antenna pointing assumptions :**
  - ⇨ Gateway antenna : 6° elevation; 0° azimuth
  - ⇨ FS antenna : all azimuths

Frequency re-use on the terrestrial path

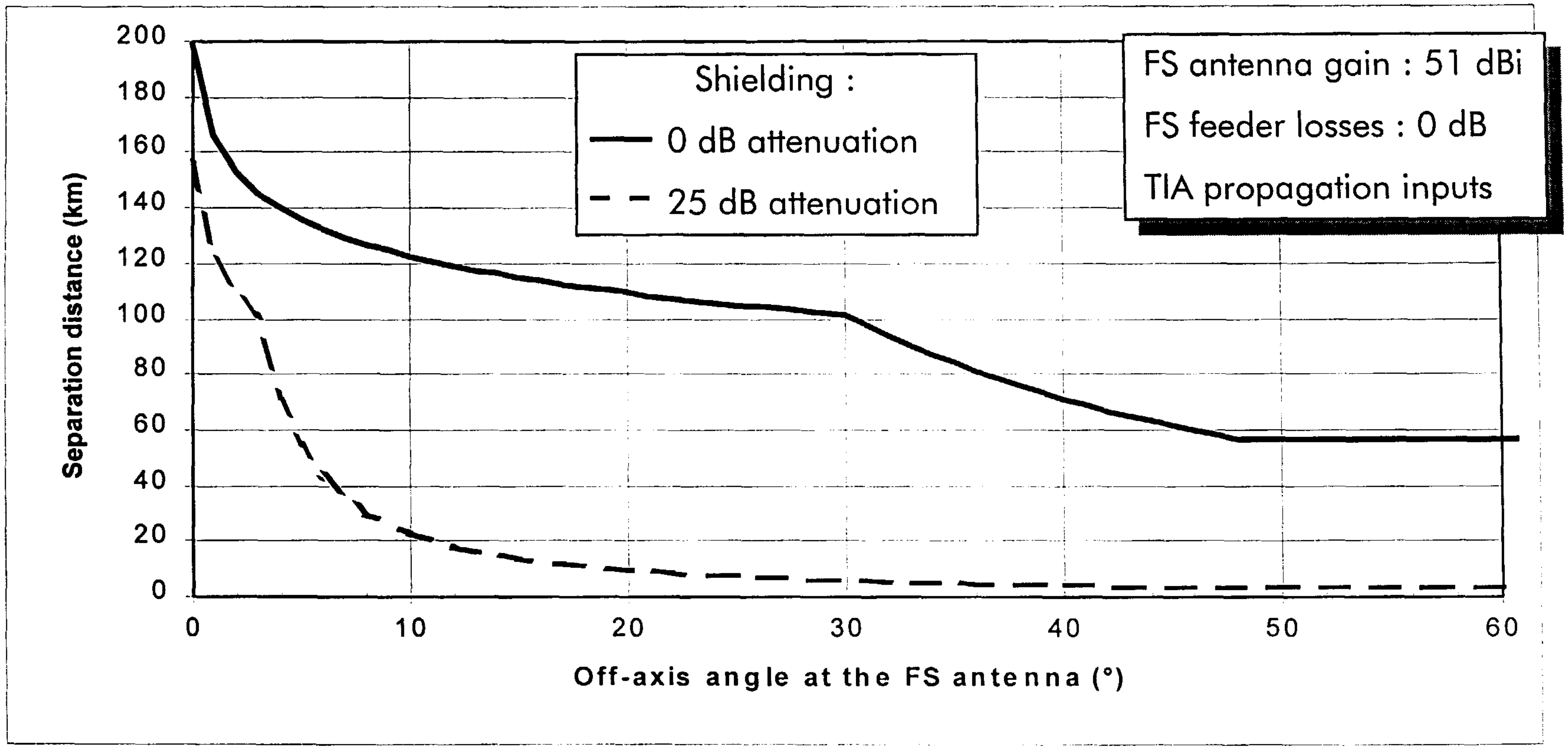
Reasons for differences between TIA and SkyBridge separation distances

- TIA calculates "worst-worst case" separation distances (i.e. FS antenna pointing in the direction of the Gateway), whereas SkyBridge calculates worst-case separation distances that will be required in most cases
- Propagation models assumptions

	TIA	SkyBridge
– FS antenna height :	50 m	20 m
– k factor	10	4/3

Frequency re-use on the terrestrial path

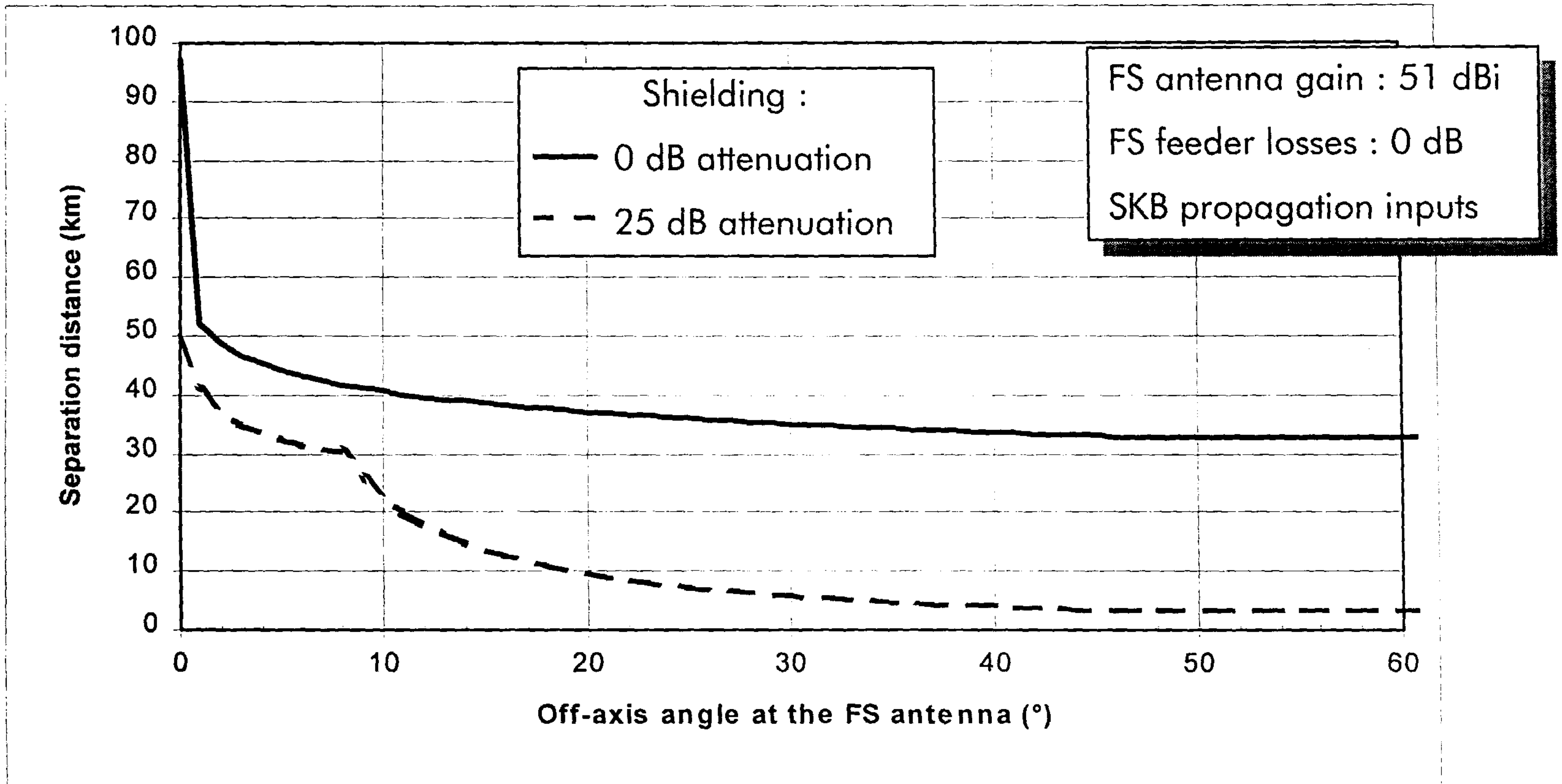
Worst-case separation distances
TIA propagation inputs



SkyBridge

Frequency re-use on the terrestrial path

Examples of separation distances SkyBridge propagation model



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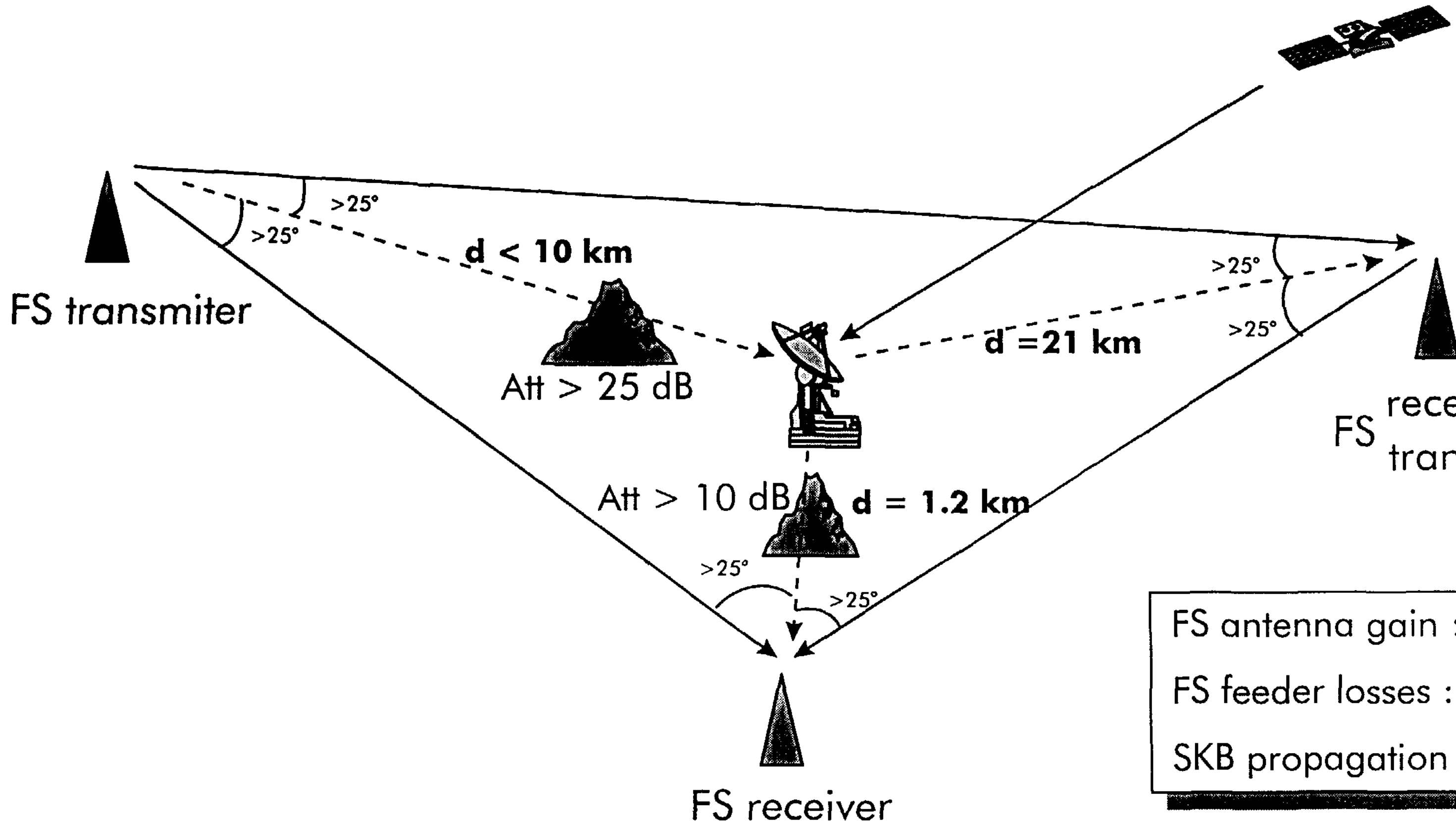
Frequency re-use on the terrestrial path

Example of implementation in a dense FS environment



FS antenna gain : 45 dBi

FS feeder losses : 4 dB

SKB propagation inputs

Frequency re-use on the terrestrial path

Conclusion

⇒ Siting of SkyBridge is feasible even in dense FS environment

⇒ Separation distances between SkyBridge gateways and FS systems is not burdensome

⇒ Siting of future FS systems is possible

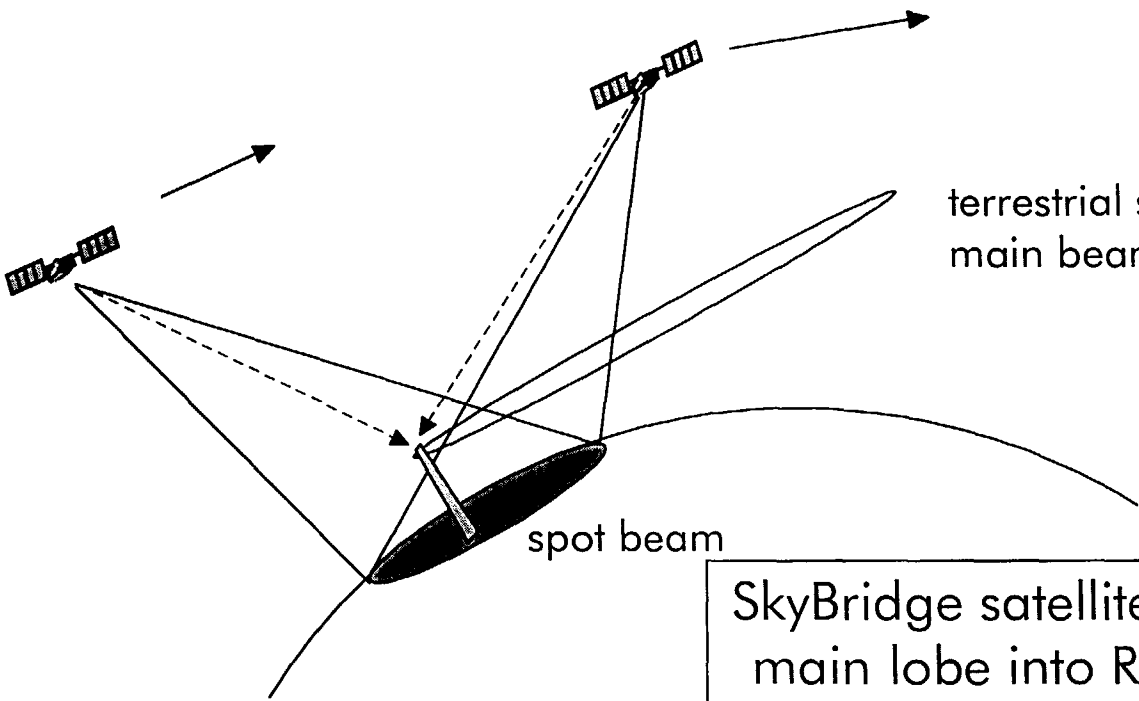
Future FS growth is feasible

FREQUENCY RE-USE

With FS systems on the downlink (slant path)

Downlink signals into FS systems

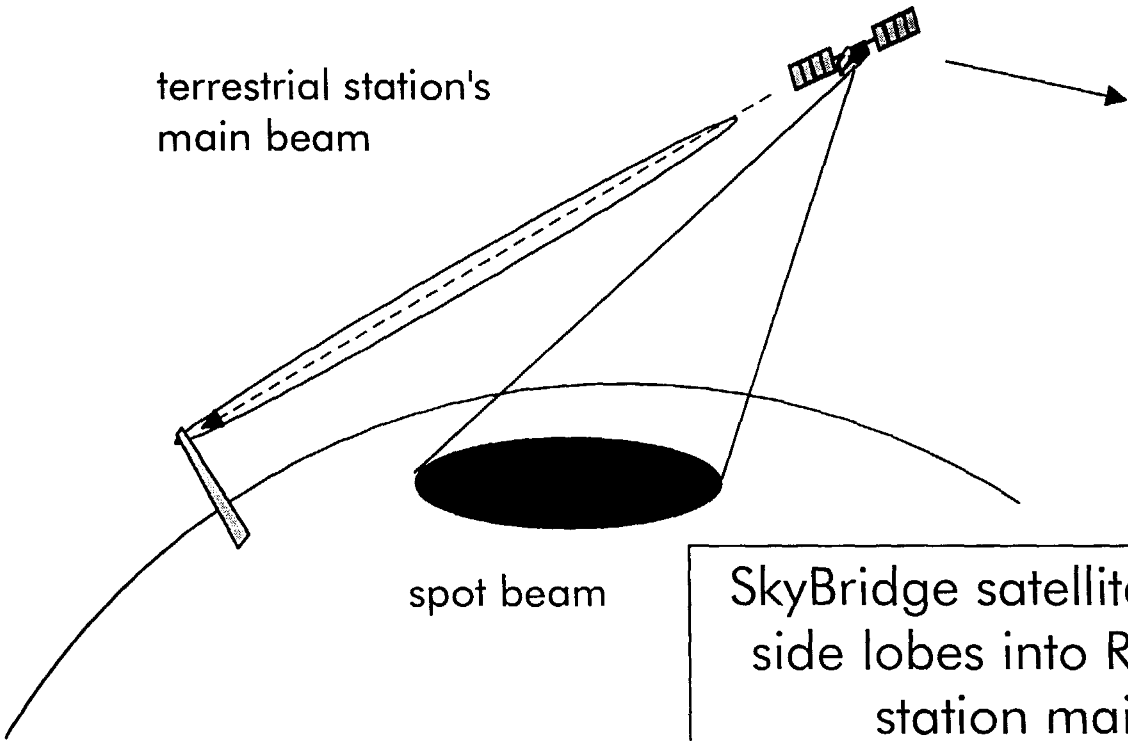
Long-term situation



SkyBridge satellite Tx antenna main lobe into Rx Terrestrial station side lobes

Downlink signals into FS systems

Short-term situation



SkyBridge satellite Tx antenna side lobes into Rx Terrestrial station main lobe

Downlink signals into FS systems

Protection of FS systems

Fixed Service systems are protected if :

- there is no degradation of service or availability of Fixed Service links

- the Fixed Service system operators have no additional regulatory and design constraints

Downlink signals into FS systems

Methods for determining statistics of interference levels at FS Rx input

- Specify location of FS Rx
- Determine the "worst-case" pointing azimuth of the FS receiver antenna
- For each time step of the simulation :

  Calculate the aggregate power at the Rx input produced by all the visible space stations of the non-GSO FSS
- Determine the cumulative distribution function of the power levels
- Compare with FS protection criteria

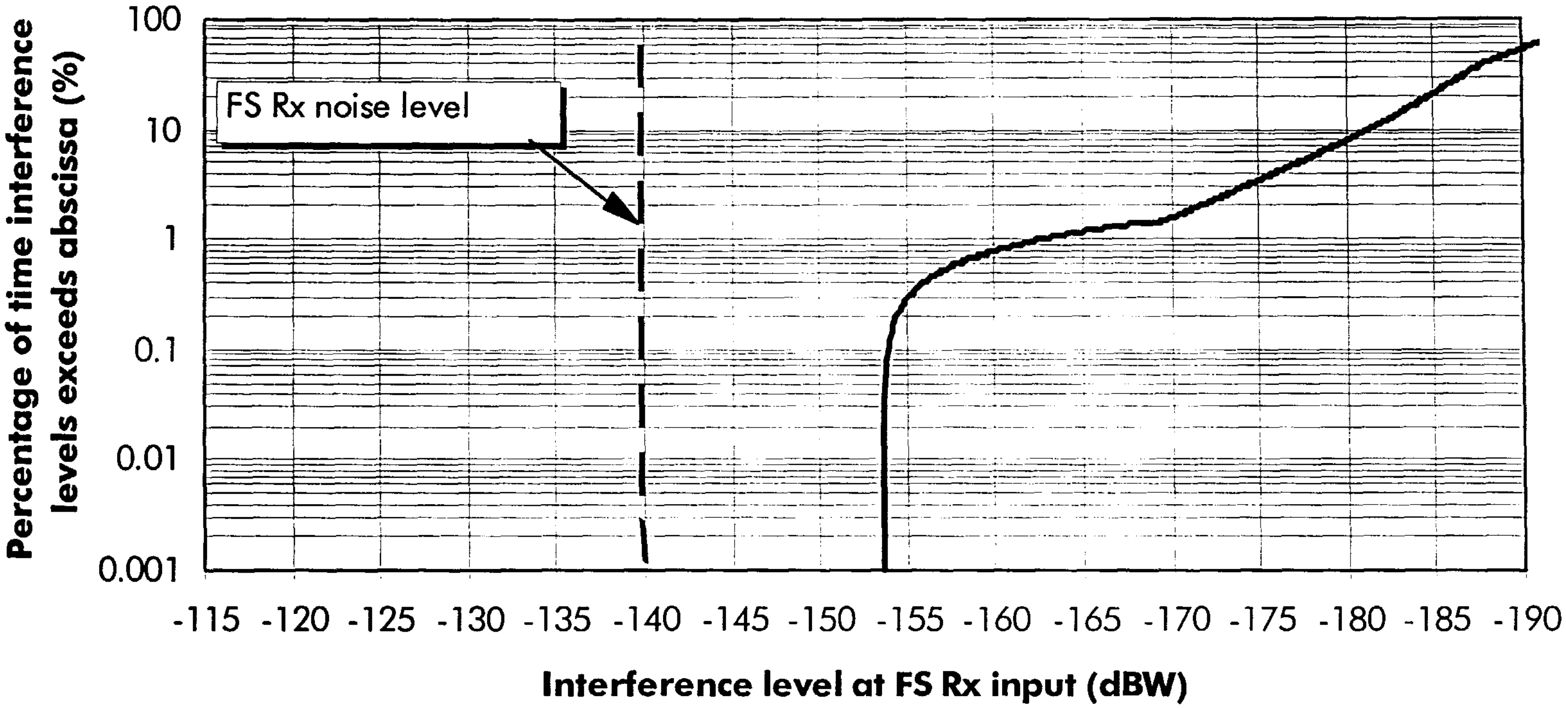
Downlink signals into FS systems

Characteristics of the FS systems in the 10.7-11.7 GHz band

	Typical design	**Worst-case design** ITU-R F.758-1
• Noise figure (dB)	4	4
• Receiver noise power density (dB(W/MHz))	-140	-140
• Feeder losses (dB)	4	0
• Max. antenna gain (dBi)	45	51
• Antenna pattern	Rec. ITU-R F.1245	Rec. ITU-R F.1245

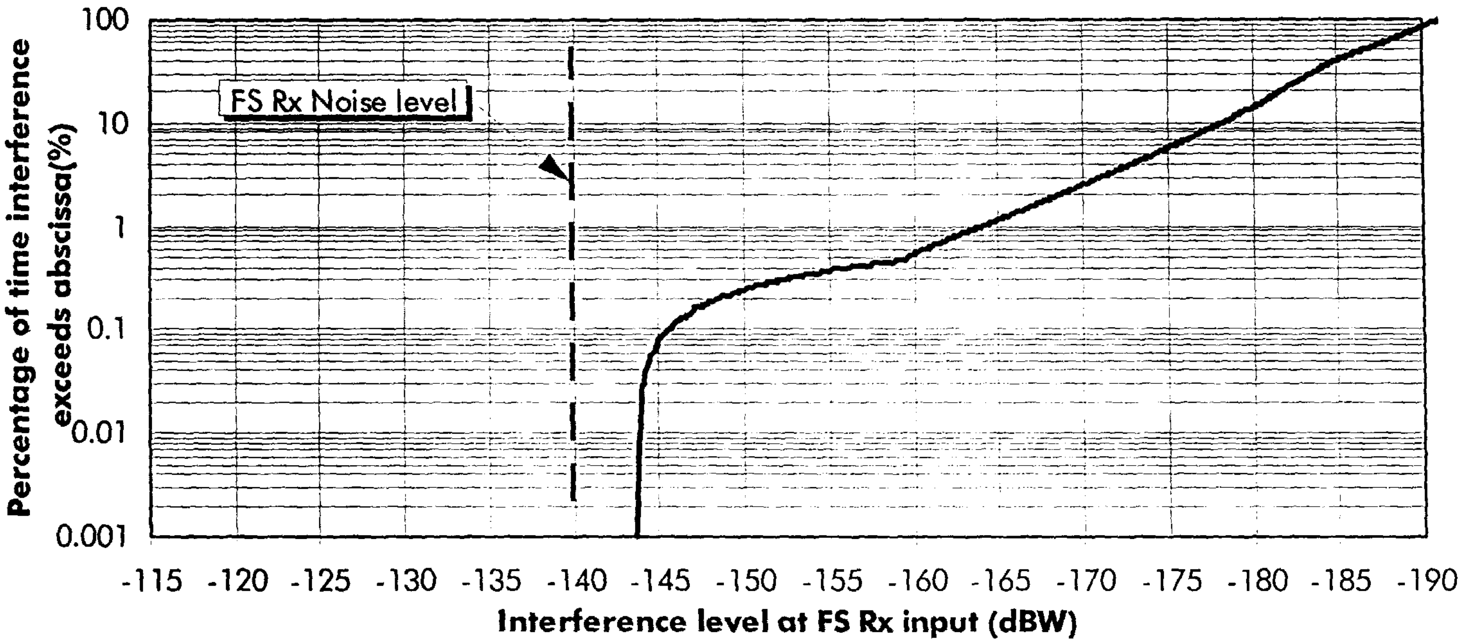
Downlink signals into FS systems

Worst-case results in the 10.7-11.7 GHz band
Typical case design



Downlink signals into FS systems

Worst-case results in the 10.7-11.7 GHz band
Worst-case design



Downlink signals into FS systems

Conclusion

SkyBridge
fully protects FS systems
in the 10.7-11.7 GHz band